What is Claimed is:

[c1] 1.A method of designing the operations and controls of a gas turbine, comprising:
generating an operations model for the gas turbine including at least one objective function;
defining operations and control constraints for the operations model of the gas turbine;
providing an online dynamic optimizer/controller that dynamically optimizes and controls operation of the gas turbine using model based control based on the operations model and the operations and control constraints.

[c2] 2.The method according to claim 1, wherein the model based control comprises model predictive control.

[c3] 3.The method according to claim 2, wherein the optimizer/controller performs following steps in a loop: (A) estimating the current engine state and applicable constraints; (B) for a given control/simulation time period, determining a action by optimizing an objective function based on the operation model while respecting the applicable constraints; (C) executing the control action determined in step (B).

[c4] 4.The method according to claim 3, wherein in step (B), determining a control action by optimizing an objective function comprises predicting the gas turbine engine states and applicable constraints.

[c5] 5.The method according to claim 1, wherein the desired operations models include set points for various parameters based on the steady state and transient operations of the gas turbine.

[c6] 6.The method according to claim 5, wherein the parameters comprise an inlet guide vane angle, an inlet bleed heat, and a fuel flow related values.

[c7] 7.The method according to claim 1, wherein the dynamic optimizer uses sensors for computing measured values of various engine states or parameters related to the operations of the gas turbine.

[c8] 8.The method according to claim 7, wherein the dynamic optimizer/controller uses software sensors for estimating unmeasured values of other parameters based on the measured values.

[c9] 9.The method according to claim 1, wherein the operations model comprises a multivariable nonlinear model.

[c10] 10.The method according to claim 9, wherein the optimizer/controller approximates the non linear model with a set of piece wise linear models for prediction and/or optimization purposes.

[c11] 11.The method according to claim 2, wherein the optimizer/controller reduces the risk of constraint violation by proactive control actions responsive to the model predictive control results.

[c12] 12.The method according to claim 1, wherein the optimizer modifies the objective function and the constraints are modifiable online to optimize operational results and/or compliance with applicable constraints.

[c13] 13.The method according to claim 1, wherein the operations model is adjustable online based on the data from a specific machine.

[c14] 14.The method according to claim 1, wherein the operations and control constraints are dynamically adjusted to optimize a tradeoff between competing objectives related to the operation of the gas turbine.

[c15] 15.The method according to claim 14, wherein the constraints may be relaxed as a result of the tradeoff on risks related to the operation of the gas turbine.

[c16] 16.The method according to claim 1, wherein the step of defining operations and control constraints comprises identifying one or more of combustion related constraints, compressor related constraints, hot gas path related constraints, minimum and maximum operating limit related constraints, control margin related constraints, and constraints related to actuators and sensors.

[c17] 17.The method according to claim 1, wherein the controller portion of the optimizer/controller is configured to perform the following steps iteratively:

receiving sensor inputs of measured values and computing other nonmeasured values based on the measured values;
adjusting the operations model based on the input measured values and/or the computed nonmeasured values;
computing engine state and constraints predicted values over a prediction horizon based on the input measured values and/or the computed nonmeasured values and the operations model;
using the engine state and constraints predicted values to evaluate the objective function and constraints in order to generate control actions over a control horizon.

[c18] 18.The method according to claim 1, wherein the operations model comprises a compressor inlet model, a compressor model, a combustor model, a turbine model, a generator model, a sensor model, and an actuator model.

[c19] 19.The method according to claim 18, wherein each of the models comprises one or more mathematical equations.

[c20] 20.The method according to claim 1, wherein the dynamic optimizer optimizes the objective function as a solution to a quadratic programming problem.

[c21] 21.The method according to claim 1, wherein the dynamic optimizer comprises non linear model based optimization solutions.

[c22] 22.A system for designing the operations and controls of a gas turbine, comprising:
a computing unit with an input unit for generating an operations model for the gas turbine to include at least one objective function and for defining operations and controls constraints for the operations model of the gas turbine; and
a dynamic online optimizer/controller configured to dynamically optimize and control operation of the gas turbine using model based control based on the operations model and the operations and control constraints.

[c23] 23.The system according to claim 22, wherein the model based control comprises model predictive control.

[c24] 24.The system according to claim 22, wherein the optimizer/controller is configured to perform the following steps in a loop: (A) estimating the current engine state and applicable constraints; (B) for a given control/simulation time period, determining a control action by optimizing an objective function based on the operation model while respecting the applicable constraints; and (C) executing the control action determined in step (B).

[c25] 25.The system according to claim 24, wherein in step (B), determining a control action comprises predicting the gas turbine engine states and applicable constraints.

[c26] 26.The system according to claim 22, further comprising sensors for measuring or computing measured values of various engine states or parameters related to the operations of the gas turbine.

[c27] 27.The system according to claim 26, further comprising software sensors for estimating unmeasured values of other states or parameters based on the measured values.

[c28] 28.The system according to claim 22, wherein the operations model comprises a multivariable nonlinear model.

[c29] 29.The system according to claim 28, wherein the optimizer/controller is configured to approximate the nonlinear model with a set of piece wise linear models for prediction and/or optimization purposes.

[c30] 30.The system according to claim 22, wherein the optimizer/controller is configured to reduce the risk of constraint violation by proactive control actions responsive to model predictive control results.

[c31] 31.The system according to claim 22, wherein the optimizer/controller comprises an interface that allows the constraints to be modified online and the optimizer is configured to modify the objective function.

[c32] 32.The system according to claim 22, wherein the optimizer/controller is configured to adjust the operations model online based on data from a specific machine.

[c33] 33.The system according to claim 22 wherein the operations model comprises a compressor inlet model, a compressor model, a combustor model, a turbine model, a generator model, a sensor model, and an actuator model.

[c34] 34.The system according to claim 22 wherein the controller portion of the optimizer/controller is configured to perform the following steps iteratively:
receiving sensor inputs of measured values and computing other nonmeasured values based on the measured values;
adjusting the operations model based on the input measured values and/or the computed nonmeasured values;
computing engine state and constraints predicted values over a prediction horizon based on the input measured values and/or the computed nonmeasured values and the operations model;
using the engine state and constraints predicted values to evaluate the objective function and constraints in order to generate control actions over a control horizon.

[c35] 35. A computer readable data storage medium having program code stored thereon for designing the operations and controls for a gas turbine, the program code configured to cause a computing system to perform the following steps comprising:
generating an operations model for the gas turbine include at least one objective function;
defining operations and control constraints for the operations model of the gas turbine;
providing an online dynamic optimizer/controller that dynamically optimizes and controls operation of the gas turbine using model based control based on the operations model and the operations and control constraints.

[c36] 36.The computer readable data storage medium according to claim 35, wherein the model based control comprises model predictive control.